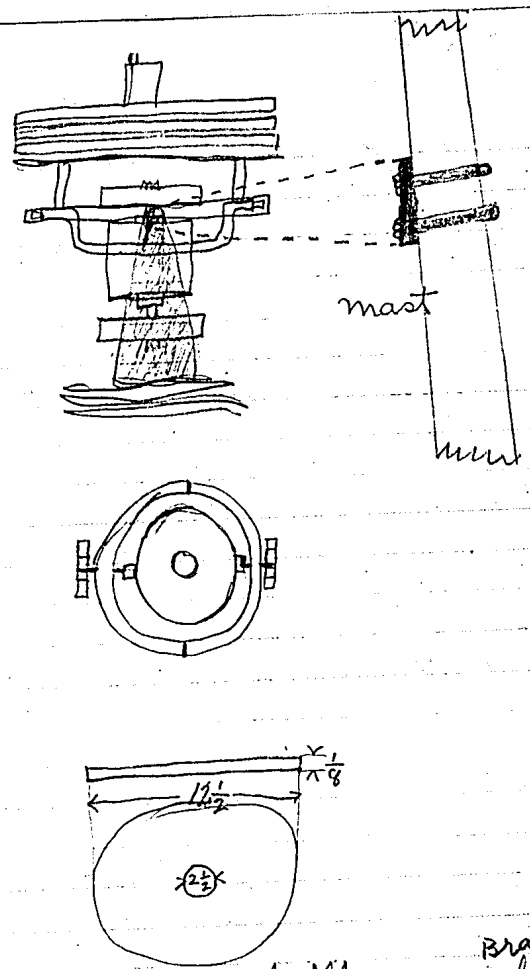
Notebook Series -- Notebooks by Experimenters Other Than Edison
Navy and Wartime Research Experiments -- Miscellaneous Books
Notebook N-18-03-03

This notebook was used by Paul D. Payne during March-April 1918 and December 1918-February 1919 for notes on experimental work done for the U.S. Navy. Payne was a Naval lieutenant assigned to work with Edison during World War I. He was reassigned in March 1919 but worked again for Edison during the 1920s. The experiments in this book, some of which were conducted at the U.S. Naval Station in Key West, Florida, pertain to the development of an airplane stabilizer to suppress undesired pitching motions. The notes indicate that the work was done under Edison's supervision; some of the entries contain Payne's description of Edison's comments. The flyleaf bears the date of August 20, 1918. A two-page final report by Payne, dated March 19, 1919, has been inserted into the book. The book contains 60 numbered pages; pages 21-30 and 53-60 are blank.

81082
Acme Co.,
MFG. STATIONERS,
96 JOHN ST.
AND
19 PLATT ST.
NEW YORK.

Paul O. Payne
Thos. A. Edison Laboratory
August 20, 1916.

Key West, Florida.
March 3, 1918
To
August 6, 1918



Light projector built up of 4 Brass discs $\frac{1}{8}$ thick spaced $\frac{1}{8}$" apart using 5 c.p. carbon lamp in center. The separate beams of light from slots grow larger for a distance of 12" from periphery of discs

and at this point merge making a decidedly visible slot i.e. visible from above or below the plane of slots.

Now we try spacing discs $\frac{1}{16}$" Result is the beams again combine.

next we space them $\frac{1}{32}$" with only slightly better results.

must increase thickness of discs.

made discs $\frac{1}{2}$" thick $12\frac{1}{2}$" dia. ~~wood~~ allowing $\frac{1}{32}$" slots. Coated discs with lamp black to cut down reflected rays. This experiment proved very good. Beams of light do not grow large enough to meet.

The wooden discs warped badly preventing the light from showing in many places.

next we made discs from aluminum $\frac{1}{2}$" thick $12\frac{1}{2}$" dia much too heavy. Cut grooves

in same but they remained too heavy.

Discarded aluminum for mahogany, pied up, $\frac{3}{8}$" thick $12\frac{1}{2}$ dia. This construction proved good.

mounted lamp above centre of discs in aluminum cup painted same white enamel also painted centres of discs this reflected light showed up very brightly at 500 yards. Only visible within the space about 2 ft above and below the plane of slots.

Experiments on stabalized plane for running light

Original device as received from Mr. Wolfe consisted of a small sewing machine motor carrying a brass wheel 6" dia $\frac{3}{4}$" rim on lower end of shaft motor held in brass tube with 4 brass discs $\frac{1}{8}$" X $12\frac{1}{2}$" on top this element was mounted in gimbal rings with wheel about 10" below gimbal axis. Gimbals were equipped with plain bearings which had too much friction. The machine had a tendency to assume a rapid rotary motion and would not stay within 5 degrees of its proper plane.

This motor much too light having only $\frac{3}{16}$ shaft. We put in new shaft $\frac{1}{4}$" and installed ball bearings in gimbals. Experimented with this machine by moving

element up and down making it more or less pendulous but obtained very little better results.

We assumed that an extra wheel operating above axis of support might counteract the rotary error caused by lower wheel. Made new wheel same size as first one and mounted same. By long experimenting we found a position where error was at a minimum but not nearly good enough for practice.

Had an accident which wrecked sensitive element. Both wheels carried away and bent motor frame and shaft beyond repairs

Made specifications for heavier motor which Mr. Edison had made at the Laboratory

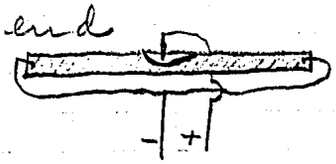
- Made new gimbals and bracket installed ball bearings at all gimbal intersections. Made new wheels. motor shaft $\frac{5}{16}$ while specifications called for larger. Removed shaft and installed one $\frac{25}{64}$ dia. also replaced single row ball bearings with double row S-K-F bearings. Rewound armature and assembled machine. Located element at point where oscillation at a minimum. Results fair only.

April 1918

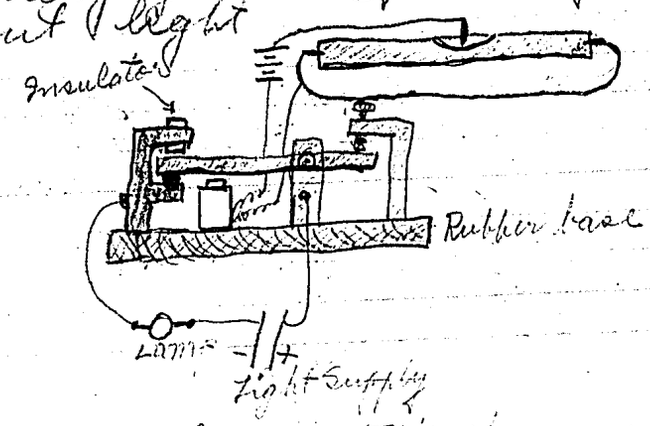
Next time considered a device for cutting out the light in case of more than 2°3' tilt

Used a straight glass tube $\frac{1}{4}$" bore 6" long filled with mercury except a bubble $\frac{1}{2}$" long. Mounted tube parallel to plane of disc. Placed one contact of a relay circuit in center of tube and a common at either end

Inclinometer Exp. No 1.

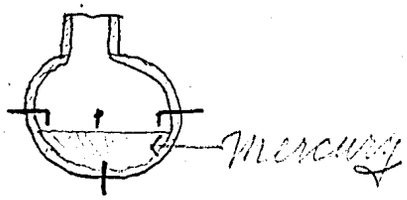


purpose: when element leaves its normal plane mercury closes circuit between contacts which energizes relay cutting out light



when element tilts the mercury banks up in one end of tube and changes balance which causes it to remain in position to which it tilts. N.G.

we then made a glass bulb 1½" dia. with 4 contacts at equator and a common at bottom

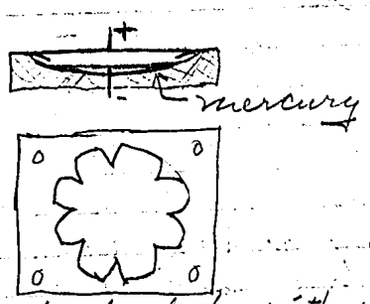


a curved container is preferable to the straight because a movement or tilt will not cause the mercury to spoil balance

I found that with the mercury level adjusted to make contact with 20° tilt the space between its surface and contact point is so small that any slight vibration or jar will cause the mercury to close circuit whether or not the element is tilted.

If I increase the radius of the container's curvature I will have enough movement of mercury to allow

The contacts to be spaced so far from mercury that vibration will not close the circuit. Consequently I make a wooden container having a radius of 10" and I mount it 10" below gimbal axis which puts the mercury at the periphery of a 20" circle



copper contact plate with points extending into mercury cup. These points are used so a minimum amount of mercury may be used. When element tilts more than

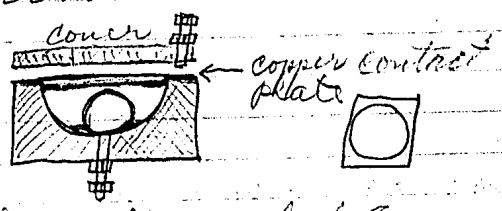
$\frac{1}{2}$° the mercury banks up against cover destroying balance. Space will not permit a cup with large enough arc to prevent this banking up.

This arrangement allows enough movement of the mercury at 15° tilt but the mass is so unstable as to be unreliable i.e. it closes circuit when element has not tilted and if element does tilt and returns to its plane the inertia of the mercury prevents it acting properly.

I next cover the mercury loosely with silk and secure a copper contact disc on top of silk expecting the weight of disc to damp excess movement of mercury. This experiment was fair but the contact

between disc and copper plate proved too light and unreliable.

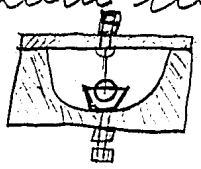
In the next experiment I use a brass ball in the cup and only a very little mercury to keep contact between ball and common



This also I discarded. Too sensitive. Ball has too much freedom.

Next experiment I use a ball large enough to almost fill the radius of cup. This, as in the silk and disc experiment, makes too light contact. N. G.

I now mount a short pendulum in the box



I am simply repeating the experiment in different forms for it is obvious in this as in the others I have too much oscillation

Mr. Edison desires an instrument which will more nearly synchronize the plane in preference to perfecting a gyroscope. Slight flashes light and too infrequent.

I find that the rapid rotary motion of the element obtains only in the direction of the wheels' rotation. Therefore I propose mounting 2 separate motors in the same gimbals each provided with a wheel and running in opposite

directions reasoning that if the rotary motion is only in the direction of which rotation the tendency of one wheel to rotate the element will be neutralized by the other wheel's tendency to rotate it in the opposite direction.

Mr. Edison is in favor of a 2 wheel unit driven by one motor

I construct this machine only to find that one wheel not only cuts out the tendency of the other to rotate the element but they each neutralize the gyroscopic effect of the other.

Mr. Edison claims the rotary motion is caused by air friction and eddy currents of air as in the

case of a shell in flight drifting. He suggests we run out wheels in same direction and seal them in a vacuum.

The German Gyro Compass which makes 24,000 R.P.M. runs in air.

I enclose entire element in a case and produce 28½ in. vacuum therein but this does not produce results.

We now attach a dashpot to element and stationary part at Mr. Ex order. This method is wrong for while it removes rotary motion of machine it also energizes same causing precession

I now run the 2 wheels at different speeds and directions as the rotary effect is so easily damped. I think by running one wheel 12,000 and the other at 6,000 I will have the neutralizing effect of the slow wheel and the gyroscopic effect of the difference in it's speed and the speed of the fast one

This experiment only partly successful, I vary the ratio of speeds up and down gradually but cannot find a combination which is right

according to all gyroscopic theory this rotary effect is unnatural therefore there must be some very simple way of overcoming it

I now mount a wheel 3½" dia. 4" below gimbal axis on center line of element. This wheel is on a horizontal shaft parallel to inner gimbal axis and driven by a belt at 6,700 R.P.M. Result: This partly damps rotary motion by cutting down one component of same.

Now I mount a second small wheel 4" below gimbal axis on center line of element spun 6,700 with shaft horizontal but at right angles to inner gimbal axis. This partly supplies the other component of rotary motion but not enough.

Now, I lower both wheels to 6½" below gimbal with slightly better results.

Next, I reverse the directions of rotation of both small

wheels. N.G.
Then I run small wheels in opposite directions. N.G.
now, reverse both small wheels again, N.G.
Rotate small wheels both in same direction and run only one large wheel. Bad.
Rotate small wheels in same direction and other large wheel only. Bad.

now, I will run both small wheels same direction both large wheels same direction and change ratio from (large wheels 1 to small wheels 1) to (large wheels $1\frac{1}{8}$ to small wheels 1) this exp. no better
next I change ratio from above to (large wheels $1\frac{1}{4}$ to small 1) no better. now change ratio from above to (large wheels $1\frac{7}{8}$ to small 1) N.G.
Change ratio from above to (large W. $\frac{3}{4}$ to small W. 1) N.G.

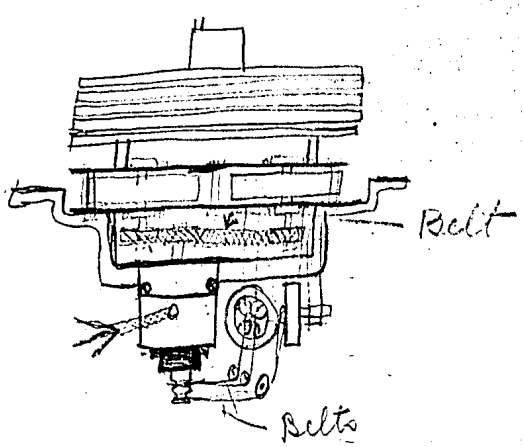
Ratios in above experiments.

1 to 1	6,700		R.P.M.
$1\frac{1}{8}$ " 1	7,537 to	6,700	"
$1\frac{1}{4}$ " 1	8,375 "	6,700	"
$\frac{7}{8}$ " 1	5,863 "	6,700	"
$\frac{3}{4}$ " 1	4,926 "	6,700	"

Feb. 24, 1919

Referring to note on page 33:
In order to obtain stability with this construction it is necessary to operate both large wheels as well as both small ones.

It seems reasonable that if the device was properly proportioned and balanced one large wheel would be sufficient to supply enough force, using two small wheels to stabilize the apparent gyroscopical phenomenon.



Dec 1918
With this construction the device will maintain its plane well. Starting up machine when [illegible] moved roughly it will settle down in about 15 min. after motor is started

Dec 1918

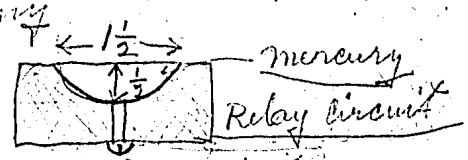
2 wheels 6" dia. running with shafts vertical on same horizontal plane, concentric with gimbal axis. One wheel 3½" dia mounted 6½" below gimbal axis ½" from center line of element shaft horizontal. This method overcomes rotary motion by stabilizing element in the plane of small wheel's shaft but allows the other component of the rotary motion to show up at right angles to plane of shaft.

Mounted an additional small wheel with shaft at right angles to other small wheel shaft. Removed 1 larger wheel. Both small wheels in this experiment were mounted 4½" below gimbal axis, 2½" from center line, one on either side. Result very unsatisfactory. Instead of removing rotary motion same increased and element left its plane entirely and continued to precess.

mounted element in gimbals seems too heavy on bottom.
Raised wheel ½ in. Result much better.
Since mounting the 2 stabilizing wheels the element does not take up the rapid rotary motion as before but seems to have lost some of its fixity
(note) page 20.
Replaced large wheel which was removed in last experiment this made much difference seeming to equalize the forces element now remains stable.

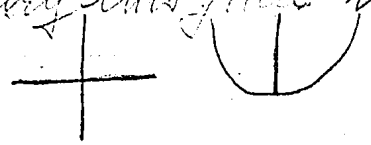
Resumed experiments on mercury contact maker.

made small mercury cup of mahogany



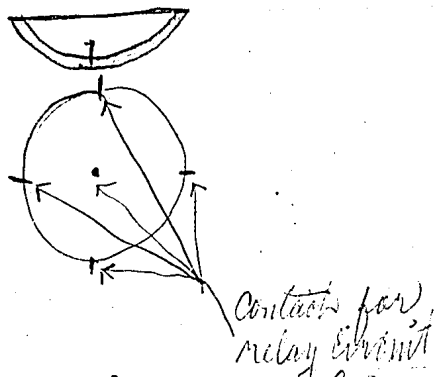
contact on top and bottom for
mounted same on top of
light housing.
Not enough movement

in a cup of this radius when element tilts 20'
This exp. is a duplicate of a former one
next I constructed a device consisting of 2 ⅛" brass tube bent with a radius of 9½"
Placed them at right angles to one another and mounted below element. Filled with mercury this gives me a



movement of ⅙" of mercury when machine tilts ½°
The mercury having an affinity for brass will become dirty and fails to move freely also when sealed with atmosphere the mercury will not compress air in ends of tube enough to make contact. N.G. unless tubes are nickel plated inside and exhausted of air after sealing.

Next I make a container of 2 6" glass dishes placed $\frac{1}{16}$" apart

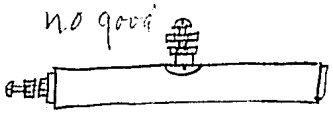


It seems that in this construction I have gotten away from the unstable effect of the mass of mercury which I found in former experiments

These dishes I seal together and remove the air from the space which will prevent the mercury from oxidizing and becoming sluggish

Jan. 11, 1919

Constructed new inclinometer like exp. no 1. no good



39 Jan. 13, 1919.

Experimenting with gears to replace belt drive for small wheels.

Estimating changes necessary to make commercial machine

Jan 14, 1919 40

Suggestions for refining construction

1 Provide quieter gear drive for large wheels

2. Change small wheel drive from belts to gears.

3. Provide accessible oiling system.

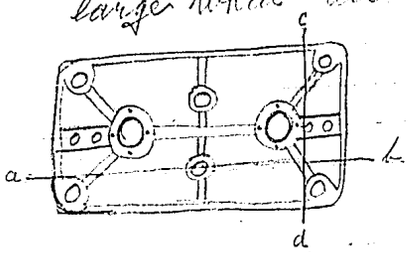
4. Design gimbals to be cast.

5. Design webbed plates for large wheel unit.

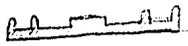
6. Design Inner gimbal with motor in center.

Jan 17

Construction of plates for large wheel assembly

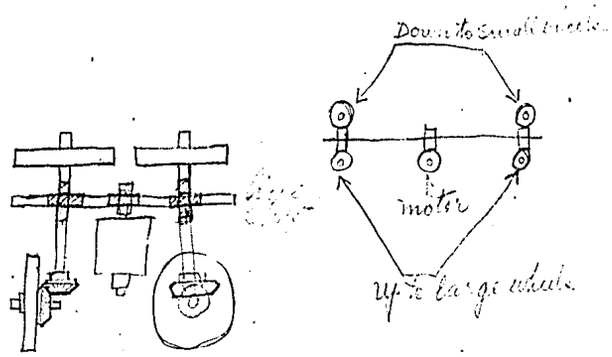


Section on a b



Section on c d

Jan 18



Showing arrangement of spiral and miter gears

43 Jan 25

Scheme No 1 for mounting gears and bearings on Line Shaft

Bearings required

S.K.F. Bearings nos. 900(1) 1200(8) and 13304(4) 13301(6) 16608(4) 18157 (2) 18156(2) → spec.

Bearings will be distributed as follows:

Line Shaft	: 4	No. 16608
Counter "	: 2	" 18157 & 2 No. 13301
Small Wheels	: 4	" 13301
Motor	:	
Gimbals	: 6	" 1200
Large Wheels	: 4	13304

Jan. 31. 1919.

Details to be drawn
1 wheels, Large and small
Shafts for same
Stud for large wheel frame
Top plate for frame
Bot. " " "
Top bearing caps
Bot. " "
Brakes for small wheels
bearing caps for same
shafts, counter, for small wheels
Line shaft from motor
Hangers for line shaft
Inner gimbal
Small + large gimbal rings
main bracket.
Sheaves for line shaft

1 Large wheel
2 Shaft for large wheel
3. Three nuts for large wheel shaft
4 Small wheel
5 Shaft for small wheel No. 1
6 " " " " No. 2
7. Three nuts for small wheel shaft
8 Line shaft.
9 Three sleeves for line shaft
10 One nut " " "
11 Counter shaft
12 One nut for counter shaft
13 One-bearing bracket for small wheel No 1
14 Two- " " " " " "
15 One- " " " " " No 2
16 Two- " " " " " "
17 Bearing cap for small wheel bracket
18 R. H. Hanger for line shaft
19 L. H. " " " "
20 Bearing cap for " " Hanger (END)
21 " " " " " Hanger (Center)
22 Top plate for frame
23 Bottom " " "
24 Studs for frame
25 Nuts " " Studs
26 Top bearing cap for frame
27 Bottom " " " " (Large)

1 & Small Bottom bearing Cap for frame

Feb 24

Run test on small, miter gears for small vehicle by driving large wheel with these gears at 6,000 r.p.m.
Run test shows this drive is fairly quiet. Showed no appreciable wear. Motor used in experiment became too hot permitting longer test.

Tested spiral gears for noise and wear. Using two brass gears in Exp. 1 two steel gears in exp. 2 ~~two~~ and one brass one steel in exp. 3 Run each test 1½ hours.
Result: all tests good but exp. 3 proved better than others. noise a minimum.

[ITEM(S) FOUND IN BOOK]

March 19, 1919

[illegible] U.S.N.

[illegible]

The details of [illegible] the classes are almost complete covered by drawings which are [illegible]

The gears are [illegible] with the exception of linear bearings bracket [illegible] the light element and [illegible] gears. The gears [illegible] are [illegible] stock [illegible] [illegible] They will have to be turned down to the size and fore [illegible] drawings.

There is quite a lot of [illegible] to be done [illegible] the parts such as locating holes [illegible] lining up brackets, gears etc.

All parts except the [illegible] in process including one stand in Bldg. 1 properly protected from dust rust etc.

Light element and the two outer gimbal rings have not

[ITEM(S) FOUND IN BOOK]

2

I can't started yet as I have
intended every time I see the
old machine I said didn't want
to convert the machine shop with
unnecessary work when I was
running. Now everything is
practically over and been.

21 has been supplied
[illegible]
machine for future reference.
I have been using some of
the parts in making other
tools but I have tried not
have the [illegible]
been short notice.

Paul A. Hayne